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From local to global. Perceptions of environmental change in a 16th century Portuguese village. A micro approach to a macro-scenario

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HIGHLIGHTS

- Climatic changes in the Early Modern Age were felt and described by common people.
- Impacts of environmental change lead to contradictory interpretations.
- Environmental changes affected daily life and interfered with political decision.
- The global "Little Ice Age" had significant regional or even local variations.

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ABSTRACT

Historical perceptions, actions and reactions toward ecosystems are the central focus of this paper which aims also at a reflexion on how an early modern historian, facing evidence from a pre-statistical era, can debate environmental changes in coastal areas and the corresponding human response. The paper, focused on the case study of Vila do Conde (a Northern Portugal small coastal village highly involved in the Portuguese Overseas Expansion in the 16th century), will approach these questions by trying to discuss how micro-approaches can contribute to the understanding of the effects of global geo-climatic phenomena; how practical knowledge induced practical actions and how public perceptions were responsible for actions over ecosystems.

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1. Introduction

We take it as agreed that Environmental History deals with the study of the relationship, over time, between human agents and the environment, which results in changes in ecosystems (Hughes, 2001). Human actions towards the environment were induced, not only by economic and political purposes, but also by the social and public perceptions of natural phenomena. The assumption that environmental changes affect humans themselves and their social dynamics, in a reciprocal process, is a parallel postulation (Hughes, 2006; Lehmkuhl, 2007; McNeil, 2003; Sörlin and Warde, 2009). What we call "Environment" is thus seen as the result of complex correlations between "Nature", as a complex ecological system, and historical dynamics, including the interference of Culture. The concept of Nurture (Goldhaber, 2012; Keller, 2010) embodies and theorizes this approach.

This kind of interaction became particularly clear in coastal areas during the Early Modern Period (1400–1800). The management of natural resources, including marine species, remains the chief concern of recent approaches of marine environmental history (Holm et al., 2001, 2010; Starkey et al., 2007). One could argue that a maritime environmental history goes beyond this approach. Recent historiographical projects and multidisciplinary teams have also been researching, for instance, the impact of floods, typhoons, earthquakes and droughts on coastal communities (Suire, 2006). It is now time to focus additionally on another dimension and ask: how did past public policies and public powers react to, and interact with, environment and climate change? Which variables induced the governance of coastal areas and common anthropic actions in order to respond to those changes? This is, without doubt, a chief concern of our days.

Finally, yet importantly, even if environmental phenomena learn from a global analysis, since nature has no frontiers, the viability of a global environmental history is under debate (Radkau, 2008; White, 1999; Wiener, 2005). In fact, neither Global History nor World History can exist without interconnecting with local, regional and inter-regional scales. Accepting this rationale implies, therefore, that no historical phenomenon, even if on a worldwide

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and global scale, can be understood without observations on a local or regional base. It is at a local level that the effects of global phenomena are identified and can be studied (Polónia, 2015).

While true today, this statement also applies to the Early Modern Age. Evaluating, on a stable basis, long-term changes and environmental processes for the pre-statistical era depends, thus, on local enquiries and microanalyses, which facilitate macro-level approaches. Changes deriving from human behaviour have also to be understood as being stimulated by local constraints, experiences and challenges. Moreover, cultural settings are also determining factors when trying to understand attitudes with far-ranging projections on the environment.

Focusing on the Early Modern Period (1500–1800), the lack of suitable sources is the main drawback for any historian trying to approach these topics. This paper will focus on a local enquiry dating from the 1540s in order to see how the different respondents perceived a very specific phenomenon: the siltation of the Ave River and the river bar, which represented the access of Vila do Conde, a small Portuguese coastal village, to the sea.

The governance of the oceans is assumed as a key point on current and past debates on the sustainability of marine ecosystems. Those are part of the concerns, e.g., of the ISCH COST action "Oceans Past Platform (IS1403)" and "Ocean Governance for Sustainability — Challenges, Options and the Role of Science (CA 15217)". Conversely, the governance of littoral areas, and its implications for the use of coastal resources and infrastructures are less represented in literature. Those are equally relevant for an understanding of how coastal communities and local powers dealt with environmental changes with direct impact on economic sustainability (Polónia, 2016), in a context in which responses lacked timely scientific or even empirical information required for the decision-making processes. Based on the argument that the power of the common people, of the socioeconomic agents in place and the strength of the self-organized mechanisms underpinning their actions were determinant factors in the relationship between men and nature (Polónia, 2012; Polónia and Pacheco, 2017), this paper seeks to enlighten the perceptions of the commoners towards the local expressions of global climatic and environmental changes, in the context of the First Global Age (1400–1800).

2. The centrality of coastal areas in the First Global Age — the Vila do Conde case study

Portuguese overseas expansion, and the building of a colonial empire, based on maritime dynamics, increased the importance of Portuguese seaports and maritime communities, giving new opportunities and introducing additional challenges, even to the small coastal villages. Studies on seaports ecosystems and impact evaluation of geo-climate changes induced on the geomorphology of seaports and coastal areas are therefore paramount (Figs. 1 and 2).

Heavily depending on the morphology and logistics of seaports, the overseas commercial enterprise demanded technical alterations to harbours, morphological transformations, and met environmental challenges that should have seriously affected short- and long term economic sustainability. Siltation of the bars' entrances and the traditional anchorage points are among them. Portuguese seaports did not meet major investments or complex technological interventions during the 16th and 17th centuries. Seaports constructions did not radically change harbour infrastructures, nor did the plans involve a new concept of public works. Even so, there were many small to medium-scale interventions. Difficulties of entrance into or exit from the harbour were the most common reason for promoting a public project on harbours or wharves. Siltation processes are mentioned most frequently as the reason for technical intervention. The need to protect the city from floods emerges as another frequent reason. All this is observable in Vila do Conde, a microcosm reflecting much more general tendencies (Fig. 3).

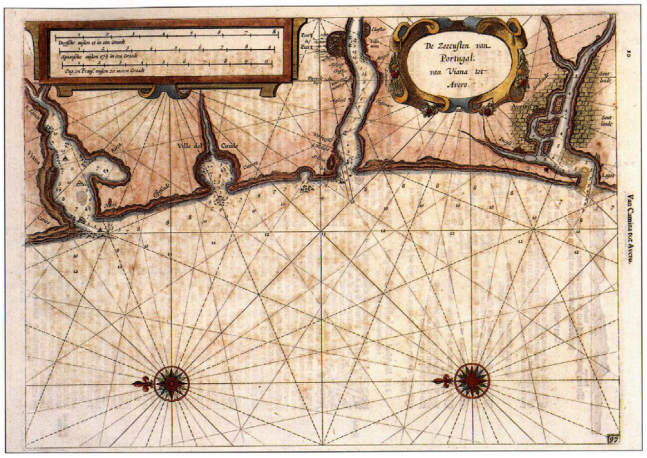

Fig. 1. North-western seaports. Cartographic representations. *Source:* Blaeu, Willem, 1638. De Zeecuten van Portugal van Viana tot Aveiro. Amsterdam, Willem Ianz Blaeu. B.P.M.P.- C (I) – 2.

Fig. 2. North-western seaports. Cartographic representations. *Source:* Waghenaer, Lucas Jansz, 1583. Die Zee Caerte van Portugal, tusschen Camino en Montego, alsoe dat landt all daer in Syin ghedaente... Leyden, Christophe Plantin.

Vila do Conde, north of Porto, was a typical small maritime community. Between 1500 and 1640, it had between 3600 and 5000 inhabitants. Naval logistics and industries prevailed (shipbuilding, rope and sails industries), along with a significant merchant fleet (one of the most important in terms of transport capacity on a national level) and a specialized maritime community.

Municipal records for this extended 16th century reveal the perception of several imbalances ascribed to human activity: the overexploitation of fish resources; the pollution of the entrance of the bar by deposition of debris and ballast of ships are some of the reasons more frequently pointed out. In their explanatory memoranda, agents of the time attempted also to diagnose the reasons for silting processes, low water levels or drastic and uncontrolled floods which endangered the safety of people and goods. Interestingly enough, human actions were mostly held responsible for those phenomena, although periods of drought or heavy rain are also mentioned as likely causes (Polónia, 2007).

The concerns with the river mouth and the bar entrance were thus paramount at a time in which siltation processes and added

Fig. 3. The river Ave and Vila do Conde. *Source:* Paiva, José Francisco de, 1821–1824. Mappa das Villas do Conde e Azurara. B.P.E., Hem. II, 4/Arm. 15–16, Est. 4.

difficulties to access the harbour called for public policies, and decisions had to be made.

3. Perceptions of the siltation of the Ave river

This is the context in which have to be seen the statements, perceptions and decisions, registered from 1540 to 1548 in a lawsuit, regarding the possible demolition of several dams, supplementary buildings to existing watermills crossing the river which, according to some of the respondents, prevented the full accomplishment of its hydraulic dynamics. The initiator of the enquiry was the district council claim to destroy the weirs supplying two watermills belonging to very powerful landlords: the Convent of Santa Clara and the Marquis of Vila Real. The former was located on the north bank of the river, while the latter was located along the southern shore, facing the convent. Together with a third group of watermills, those of Retorta, they were thought to be directly responsible for the silting of the river and bar (Figs. 4–8).

The claim was based on the assumption that by interfering with the natural course of water and tides of the river, those barriers, described in detail, affected the ability of the river to restore the balance of an already old phenomenon with recent deterioration: the deposition of sediments provoked both by inland and sea deposition. The proceedings of the enquiry refer also to the existence of a prior decision on the matter, by King Manuel I, after similar enquiries in 1505/06.

In a letter sent to the Porto Corregidor, the reasoning of the municipality representatives is summarized. The Corregidor, jointly with local residents, mostly pilots, should evaluate, in loco, the legitimacy of their claims. The drawing of the river and the bar, by a painter, with the assistance of a pilot was also planned. Unfortunately, this topographical survey did not reach our days. From the letter of the king, one might quote:

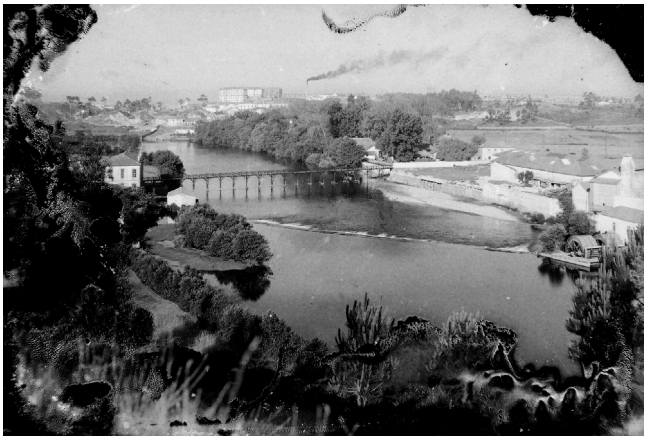

Fig. 4. Retorta watermills and bridge (middle 20th Century). *Source:* AMVC 21400 AMVC-FA-4399.

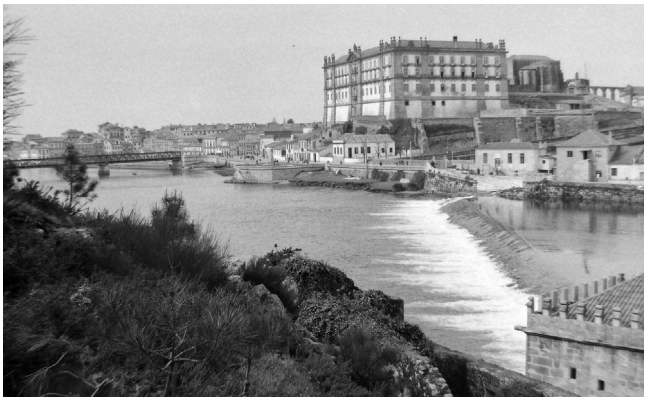

Fig. 5. Santa Clara Monastery (middle of the 20th Century). *Source:* AMVC 17429 AMVC-FA-268 5.

Fig. 6. North Bank watermills. *Source:* AMVC-FA-152 Azenhas-Portugália.

"Corregidor. We, the king, send you our greetings. The judges, good men and councillors of Vila do Conde wrote to me and said that village is very ennobled of people and great navigation

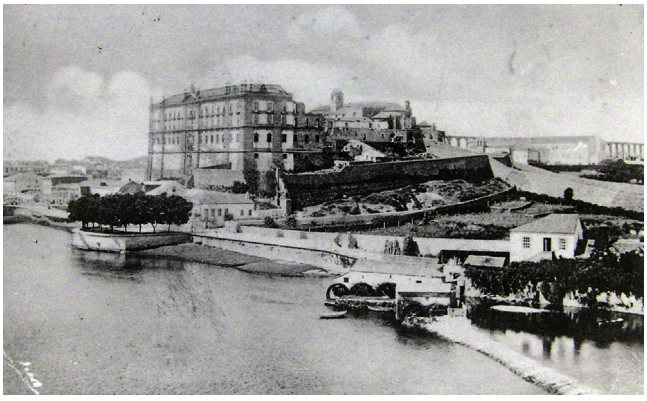

Fig. 7. Santa Clara Monastery and watermill (beginning of the 20th. Century, before 1928).
Source: AMVC 6408.

Fig. 8. Watermill on the South Bank of Ave River (s.d.).
Source: AMVC 14238.

> of ships and carracks, whose navigation is now endangered to be lost, by the fact that the river of the said village and its bar are very silted because of the "açudadas" [watermills' dams] in this river which are doing too much damage to the bar and prevent with sand the entering and exiting of ships and carracks [...] and not only is the river dammed, because it is so sanded, but also the mouth of the bar where the ships should leave, is all sanded and so low that where the ships used to float with dead waters and empty tides, now they can no longer, except for caravels and with running water (high tides) and without many people, and the bar is so dry that not even skiffs can float and the young men and boys cross it walking..." (ANTT - Conv. St^{a} Clara V. Conde, cx. 37, mç. 7, s.n., fl. 31-32).

It is nowadays common knowledge that the phenomenon of sediment deposition, responsible for significant changes in coastlines and watersheds, commonly known as "silting", is due to a multiplicity of factors involving the characteristics of the continental shelf, the action of the tides, waves and wind, along with climate change responsible for coastline variations. It also involves the yearly amount of rain, the level of the sea and the deposition of sediments coming from inland activities, including agriculture, and dune erosion. Interestingly enough, all those elements were identified by the respondents to the enquiry, when describing the alleged consequences deriving from the recent building of more extended dams to improve the production of existing watermills. The municipal representatives and most of the pilots argued that this had given rise to concrete changes in hydrographic mechanisms, such as:

1. changing the streams of tidal waters, which were shortened by the inability of water to overflow the dams;
2. the correlative change of tidal duration: the normal duration of each tide, ebb and flow, was six hours, while the survey postulated that they would not last, in fact, more than four hours, lying in the blocked course of the river;
3. the decrease of the waters' flow and strength would create winter floods in the town, and the difficulty of the passage-boat to cross the river, upon which (in the absence of a bridge) the provisioning of the town and the transportation of passengers between the two sides totally depended;
4. the consequent spreading of the river, due the trailed alluvium cultivation of land, which, transported by the ebb tide, was responsible for the silting of the river and bar via the accumulation of river sediment, contributing to the growth of the estuary, but not to the deepening of the navigation channel, upon which depended the maritime access to the village;
5. the violence of the tides, downstream from the mills, caused by the successive blockages to the progression of the waters upstream. These statements enforce the idea that the obstacles encountered by the river flow prevented its natural course, strengthening its force along the bar to such an extent that they prevented the navigation of small boats.

The arguments were frequently contradictory, and depended on the commitment of the witnesses, for or against the aims of the municipality. Pilots, shipmasters and the municipality representatives pointed out the negative impacts on navigation and access to the pier, along with the floods, as result of the dams. The representatives of the owners of the watermills, including also pilots (even if in a smaller number) underlined the beneficial effects of the dams by retaining the sand resulting from alluvium deposition upstream, which would prevent the silting of the anchorage and the entrance of the bar (ANTT - Conv. St^{a} Clara V. Conde, cx. 37, mç. 7, s.n., s.fl.).

As for causes, the first stress the weirs built across the course of the water. The latter point to the decreasing rainfall, the alluvium deposition of sediments and the fact that small sources and streams that usually thicken the river were more and more diverted and exhausted by the irrigation of corn all the way through Entre-Douro-e-Minho (the northern district to which Vila do Conde and many small-to-medium seaports belonged). Underlining their thesis, the latter stated that the river Ave was not an isolated case, and that the same phenomenon could be perceived in the Caminha, Viana, Porto, Buarcos or Aveiro rivers and bars (most of them without watermills or dams interfering with their flows). (ANTT - Conv. St^{a} Clara V. Conde, cx. 37, mç. 7, s.n., fl. 6; 42v.,73v.)

Some of these actors prefer to stress the responsibility of climate factors, citing the decreasing levels of rainfall as an example. However, most of them point to human action and anthropic interventions as major causes of the perceived phenomena, including building of dams, agriculture, irrigation systems and dune erosion by lack of human settlement on the coastline. All were identified

Fig. 9. River, dam and watermill of the Southern bank. 1st half of the 20th Century. *Source:* AMVC 6409.

Fig. 10. Watermill of the southern bank (2015). *Source:* AMVC 20311.

as contributing to silting processes. And in this case, they called for action and indeed proceeded to act. Before we return to this, let us try to analyse the process of knowledge-building and the construction of perceptions that actually led to action.

4. Observation criteria and knowledge building

In the proceedings, one can identify three main ways to collect and validate data: the actual *memory of the respondents*, that can go back in time for more than 40 and 50 years; *direct observation* (by the Corregidor and the technicians he called in); and what we could call today *archaeological evidence* (Fig. 9).

A pilot from Póvoa de Varzim, a neighbouring village, João Martions Gaio, 75 years old, supporter of the watermills, explained, based on his more than 50 years of experience with the bar and river of Vila do Conde:

> "according to God and my own conscience, it is my opinion that there is no risk for ships (entering and exiting the bar) except in Nazeiro Stone where always large and small vessels were awaiting for the ebb to pass and my opinion is that no matter how much the water would drop, never the bar will be deeper, except if you break or correct that stone, and as for costs, those to correct the bar would be half of those required to overthrow the dams [...] and without it the bar will never be higher except if one corrected the said stone." (ANTT - Conv. St^a Clara V. Conde, cx. 37, mç. 7, s.n., 46-46v.)

So, his memory of the river and coastal dynamics, and the fact that, according to him, Vila do Conde shipyards continued extremely active and the local fleet was bigger and more voluminous than ever, justified retaining the dams. A plain demolition of the major stone of the river (a human technical intervention) would resolve the problem, without significant costs and without touching the convent's property and earnings.

As for the direct observations of the Corregidor, they certainly show severe problems on the bar entrance and the ships' anchorage in the river. On January 30, 1542, i.e. during the winter, the Guimarães Corregidor, another agent involved, after dismissing his Porto colleague, could testify to those problems, reported in the proceedings (Fig. 10):

> "he, the Corregidor, with the said seafarers, went to the river and saw the bar and found the river so low at the mouth of the bar that anybody could cross it on foot and much lower than after the last observation. There, much sand was exposed, I mean much sum of sand, that the other time was covered by water, and found that three carracks were caught in the river for lack of water because they could not get out." (ANTT - Conv. St^a Clara V. Conde, cx. 37, mç. 7, s.n., 69-69v.)

Finally, and as for archaeological evidences, also called as material testimonies, a witness points out that the navigation on the river used to go, in the past, much further upstream, as could be testified by the remains both of old anchors and sub-aquatic remains of shipwrecks.

> "Item when your honour take witnesses [...] it will be proven that times in the past ships and caravels would anchor at "Monte da Povoação", where nowadays are pierced stones where those ships used to anchor and be repaired in Winter and very recently was found a ship or caravel's anchor where it seems that in the past they used to be in Winter and so they could go so far upstream, what now they cannot, and people say that one can find topsides of subverted ships under the sand and water and for that we will also provide witnesses." (ANTT - Conv. St^a Clara V. Conde, cx. 37, mç. 7, s.n., 27v-28).

As for methods of knowledge building, and interpretation, they seem to be obvious, after this description. First and foremost, they were based on *personal, practical and empirical experience*, which turns out to be less than objective, leading to contradictory interpretations. Secondly, they rely on the *direct observation of silting levels*, revealed also by the observable sea and river levels. Thirdly, *comparison* was also used: both with past registered observations and with other Portuguese seaports, mostly located on the Northwestern seaboard — which Vila do Conde pilots and shipmasters knew well. Interpretation, trying to make sense of the data collected, should be the chief lever for political action.

As for *authority criteria*, which should legitimize those statements, besides the *political* ones there was the *technical authority*, arising from a practical knowledge acquired by years of experience. That is why so many pilots and shipmasters were among the respondents. Four years later, during another survey, however, this prevalence was reverted.

5. The aftermath

The royal decision was favourable to the demolition of the dams, which occurred after November 6, 1542, date of the royal decree authorizing it. The king decided "to tear down [the weirs] all the width of the water course so that the river can flow without any impediment and so they unsilt the said wells and bar, so that the ships and carracks can come and go as they used to before" (ANTT - Conv. Stª Clara V. Conde, cx. 37, mç. 7, s.n., s.f.).

The conditions set for the implementation of this decision stipulated that the Corregidor was expected to go to Vila do Conde every year, after the winter, to find out any gains for the dredging of the river and bar entry (ANTT - Conv. Stª Clara V. Conde, cx. 37, mç. 7, s.n., s.f.). Furthermore, the royal order provided that the owners of the watermills could rebuild weirs with stacks (and not stone) as they had done some 40 years before (A.M.V.C. - Lv. 18, fl. 89). So, techniques and technology also mattered for the evaluation of the situation.

After having demolished part of the dams, at the expense of the municipality and the population, in 1546 the owners wanted to rebuild, and even improve them, arguing that, after their demolition, the situation of the river and bar entrance and access had got even worse. The statements, now by yet another Corregidor, and of different municipal representatives and far less influenced by technicians, seemed to prove exactly that.

The objections to the demolition turned out to be overwhelming, both in terms of costs (financial and regarding labour force) and technical: only in summer could they work and with extreme difficulty in order to demolish the described very strong stone dams. Plus, a very conflictive debate continued: while the one faction said that the situation had got worse because part of the dams had been demolished, and thus called for their rebuilding, the others argued that it was because they had not been completely destroyed, that the situation did not get better, calling for the dismantlement of the entire infrastructure.

6. Final remarks

At the end, what can a historian of the Early Modern Age contribute, based on the proceedings briefly presented, to an academic readership interested in debating "Changes in knowledge, perception and use of marine ecosystems of semi-enclosed basins and coastal areas"? Besides the mechanisms of regulation, participation and debate of local communities and common people in changes to coastal areas, it seems clear that political, economic and symbolic elements were actual levers of decision making in 16th century Europe towards ecological problems. Secondly, it seems to be proven that those elements, responsible for active lobbying, have, in the past as much as today, conditioned public action and private behaviour. Thirdly, it seems unquestionable that, just like today, the same objective observations (empirical or scientific) can and will lead to very different interpretations of the meaning of change, those ultimately called to justify financial investments and public actions. Lastly, these seem to depend more and foremost on the efficacy of lobbying and the predisposition to confront established powers. In our case study, the Portuguese king confronted the Santa Clara Monastery, first because he was trying, also on other fronts, to diminish that private power in the village, and because the efficacy of naval logistics was paramount for a bigger project: overseas maritime trade and the building of a colonial empire based on maritime dynamics (Polónia, 2004, 2007).

Finally, and as for the comprehension of the causes underlying this discussion, one can go from the local to the global, since, at the utmost, one identifies, as potential causes for all the observable and described micro-phenomena, evidences of a macro-one. We refer to the geomorphological and environmental changes, induced, in coastal areas, by the climate changes identified in the so called "Little Ice Age". The expression identifies a climate period that occurred from the early 14th century through the mid-19th century, when mountain glaciers expanded at several locations, including the European Alps, New Zealand, Alaska, and the southern Andes. The Little Ice Age followed the medieval warm trend (roughly 900–1300 CE) and preceded the present period of warming that began in the late 19th and early 20th centuries (Fagan, 2000; Grove, 2004; Rafferty, 0000).

Information obtained from proxy as well as historical data points to a significant variability in its climatic expressions. It indicates that cooler conditions appeared in some regions, but, at the same time, warmer or stable conditions occurred in others. Plus, regional temperature declines rarely occurred at the same time. Cooler episodes materialized in the Southern Hemisphere, initiating the advance of glaciers in Patagonia and New Zealand, but these episodes did not coincide with those occurring in the Northern Hemisphere. Meanwhile, temperatures of some regions of the world, such as eastern China and the Andes, remained relatively stable during the Little Ice Age. Still other regions experienced extended periods of drought, increased precipitation, or extreme swings in moisture. Many areas of northern Europe, for instance, were subjected to several years of long winters and short, wet summers, whereas parts of southern Europe endured droughts and season-long periods of heavy rainfall. Evidence also exists of multiyear droughts in equatorial Africa and Central and South Asia during the Little Ice Age (Rafferty, 0000).

For these reasons, the Little Ice Age, while taken broadly as synonymous of colder temperatures and sinking sea levels, can also be characterized as a period of high variability across many parts of the globe. Historical analysis of local perceptions of such geoclimatic changes and their projections on the daily life of human communities thus become essential.

As for its impacts on shores and coastal areas, there is no consensus in the literature. Even if global, this phenomenon seems to have had significant regional or even local variations. Let us take the testimony of Araújo, an expert on the impact of those climate changes on Portuguese coastal areas.

"It seems quite probable that during LIA

1. (. . .) downstream and inside the estuaries, a sea level drop will allow the sediments to migrate towards the sea, contributing to beach nourishment. The same reason should allow the rivers to cut own deposits: close to river mouth, the river channels may be narrower and incised upon the abundant sediments that characterize that climate situation, forming river terraces (. . .).
2. The sediment transported to the coastline should be deposited in coastal areas where they should construct wide beaches that strong winds could use as source for building extended coastal dunes.
3. Sea level should be a little lower than at present. This could result in a sea retreat, abandoning older beach ridges, and reinforcing the sand supply for dune building" (Araújo, 2007).

According to the empirical data made available by this paper, resulting from a research focused on a micro universe, the abovementioned indicators of this macro phenomenon seem to be identifiable. The men and women of 16th century Vila do Conde had no idea, though, they were experiencing and living in the Little Ice Age. The local actors whose voices we have heard had no idea that the evolution of the coast was heavily influenced by long cycles of climatic oscillations, through succeeding periods of erosive deposition, and transgression and regression of the coastline. But they knew, from experience and practical knowledge, that variations in sediment deposition were instrumental causes in changing the coastline and conditioned bar entrances and riverine accesses.

Their perceptions and their interpretations point, no doubt, to the understanding of variations responsible for harbour and bar entrances' accessibility, which might be also confirmed by the historians, through comparison of historical maps, archaeological data and, when available, surveys of rainfall and temperatures.

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